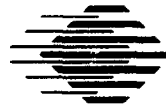


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Carnegie Mellon University
Software Engineering Institute

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Quarterly Update

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July-September 1992

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Summary of Accomplishments: 3Q92

The **Software Process Measurement Project** completed four technical reports in support of the DoD Software Action Plan Measurement Initiative, as part of a measurement notebook entitled *Defining and Using Software Measures*. The notebook was released at the SEI Software Engineering Symposium in September.

Members of the Software Process Definition Project delivered an annotated version of the **Software Process Definition Workshop** "Defining the Software Process: Getting Started" to Standard Systems Center.

The **Software Process Definition Project** also delivered a process framework based on the SEI Capability Maturity Model (CMM). The CMM process framework provides guidance in identifying the policies, processes, and the procedures that are supportive of the CMM Repeatable Level.

The **Capability Maturity Model Project** drafted and shipped CMM V1.01 to the CMM Correspondence Group for review.

The beta version of the **Rate Monotonic Analysis (RMA) Handbook** was completed in August.

Real-Time Simulators Project staff members completed and delivered an annotated outline of a guidebook on the air vehicle portion of flight simulators.

The Domain Analysis Project and the Software Architectures Engineering Project were consolidated into the **Application of Software Models Project** to address the systematic creation and application of models in application engineering.

The Application of Software Models Project members completed a tutorial for the Conference on Software Engineering Education. The tutorial was developed jointly with the Air Force Institute of Technology and is entitled "Putting the Engineering into Software Engineering."

The **Software Engineering Information Modeling Project** was formed from the Requirements Engineering, Advanced Video Techniques for Imaging, and Software Architecture Design Principles Projects, building on their results and activities.

Two commercial implementations of the **SQL Ada Module Description Language (SAMeDL)** were produced this quarter: one by Intermetrics, Inc. and the other by Competence Center Informatik (CCI).

Statistica, Inc. announced privately that they are preparing two series of educational seminars on SAMeDL; one for managers and one for programmers. The **Ada SQL Project** will be cooperating with their efforts.

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This section provides a
summary of
accomplishments from
July — September 1992

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The Government Risk Management Project signed an agreement with the National Oceanographic and Atmospheric Agency to conduct a risk assessment with potential follow-on collaborative work.

In September, the **Industrial Risk Management Project** delivered a presentation on the state of the practice in risk management at the Los Angeles area Software Process Improvement Network meeting.

The **Risk Taxonomy Project** developed a training package (Version 1.0) to train team members on how to apply the taxonomy-based questionnaire and analyze the resulting risk data.

The **Computer Emergency Response Team** coordinated two major conferences. The Fourth Workshop on Computer Security Incident Handling was held in Denver on 4-6 August, and the Third USENIX Security Symposium was held in Baltimore on 14-16 September.

The **Improvement Planning and Organizing Project** entered into agreements with the Technology Integration Center (TIC) of the U.S. Air Force to provide action planning workshops and mentoring to the initial two improvement clients of TIC.

The **Continuing Education Project** completed and delivered a major revision of the Continuing Education Series executive seminar "Software: Profit through Process Improvement" to clients on 28-29 September.

The **Carnegie Mellon Master of Software Engineering** program welcomed nine new students for fall 1992.

The **Software Capability Evaluation (SCE) Project** distributed V1.0 of the Implementation Guide to approximately 30 individuals on an industry review group.

The SCE Project conducted the first **SCE Users Workshop** in Pittsburgh during July.

The SCE Project supported an Air Force Materiel Command working group that chartered to investigate how current evaluation methods used by the Air Force (including SCE) might be merged into one technique.

The **SEI Software Engineering Symposium** was held in Pittsburgh on 15-17 September. An optional day of tutorials was held on 14 September. SEI products and services, as well as technical focus areas, were highlighted during this year's symposium.

Three new **resident affiliates** joined the SEI this quarter, one from the Department of Defense, one from Paramax, and one from Computer Sciences Corporation.

Software Process Measurement	1	Software Process
Software Process Definition.	2	
Capability Maturity Model	3	
Empirical Methods.	4	
Rate Monotonic Analysis for Real-Time Systems.	7	Real-Time Distributed Systems
Real-Time Embedded Systems Testbed.	9	
Real-Time Simulators	10	
Systems Fault Tolerance	11	
Transition Models	12	
Zero-Defect Application Kernel	13	
Application of Software Models	15	Software Engineering Techniques
CASE Environments	16	
Software Engineering Information Modeling	17	
Binding of Ada and SQL	21	Special Projects
Process Research	21	
Government Risk Management Project.	23	Software Risk Management
Industrial Risk Management	24	
Risk Taxonomy	24	
Computer Emergency Response Team	27	SEI Services
Software Process Assessment	28	
Improvement Planning and Organizing.	28	
Organization Capability Development.	29	
Academic Education	31	SEI Products
Continuing Education.	31	
Master of Software Engineering	32	
Software Capability Evaluation	32	
	35	Program Development
	37	For More Information

Software Process

The Software Process Program focuses on improving the process of software development. Projects within the program are assessing the actual practice of software engineering in the defense community, training organizations to gain management control over their software development processes, supporting the use of quantitative methods and measures as a basis for process improvement, and developing improved methods for software process management.

The Software Process Measurement Project advocates the use of measurement in managing, acquiring, and supporting software systems. The project is formulating reliable measures of the software development process and products to guide and evaluate development. To expedite Department of Defense (DoD) and industry transition, the project is actively working with professionals from industry, government, and academia in encouraging organizations to use quantitative methods to improve their software processes.

• • • • • Software Process Measurement

This quarter, the project supported measurement development, definition, and installation efforts. In July, project members hosted a follow-on meeting with action officers for the measurement work on the Software Action Plan Working Group (SWAP) and Defense Information Systems Agency (DISA) and Corporate Information Management (CIM). The focus of the meeting was to continue discussions about implementation of planning, training and dissemination issues, and follow-on activities.

This quarter, four technical reports were completed in support of the DoD Software Action Plan Measurement Initiative as part of a measurement notebook entitled "Defining and Using Software Measures." This notebook was released at the SEI Software Engineering Symposium in September. Project members presented a summary of this work and distributed the following technical reports:

- *Software Measurement for DoD Systems: Recommendations for Initial Core Measures*
- *Software Size Measurement: A Framework for Counting Source Statements*
- *Software Effort and Schedule Measurement: A Framework for Counting Staff-Hours and Reporting Schedule Information*
- *Software Quality Measurement: A Framework for Counting Problems and Defects*

During this period, three site visits were conducted in support of measurement work at Standard Systems Center (SSC), Gunter Air Force Base (AFB). The measurement support plan was approved by project sponsors at SSC.

This quarter, seven site visits were conducted in support of the Naval Air Warfare Center (NAWC) technical objectives and plans (TO&P) effort this quarter. The pilot test activity has commenced and is well into the end of the first data collection cycle. At the request of the sponsor, Richard Mitchell, James Rozum and Charles Koch (NAWC) are writing a paper on experiences and lessons learned with measurement at NAWC.

Project members completed two SEI technical reports: *Software Measures and the Capability Maturity Model* and *A Concept Study for a National Software Engineering Database*. The authors presented the results of their efforts at the SEI Software Engineering Symposium in September.

Mary Busby, resident affiliate from IBM was the author (with Wolfhart Goethert and Elizabeth Bailey) *Software Effort and Schedule Measurement: A Framework for Counting Staff-Hours and Reporting Schedule Information* and provided an introductory presentation for the half-day measurement framework workshop at the SEI Symposium. Busby has been instrumental in drafting preliminary plans and outlines for measurement installation materials and workshops.

This quarter, project members made several presentations and participated in a variety of seminars. They presented finalized presentation materials and conducted dry-run talks in support of the SEI Software Engineering Symposium. Anita Carleton, Robert Park, and Wolfhart Goethert presented status and activities on the measurement initiative in support of the DoD Software Action Plan to the Software Process Program Advisory Board in July. Anita Carleton and Robert Park supported the Navy Quality Management Board Meeting at the SEI in August.

Also this quarter, Anita Carleton provided a presentation on the primary current and future activities of the measurement project to the Joint Advisory Committee on 18 August in Washington. Donald McAndrews made a presentation on "Establishing a Software Measurement Process" at the Fourth Annual Rome Laboratory Software Quality Workshop in Alexandria Bay, New York held in early August. James Rozum attended the Deming seminar entitled, "Quality, Productivity, and Competitive Position," which took place on 11-14 August in Indianapolis.

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**Software Process
Definition**

The objectives of the Software Process Definition (SPD) Project are to establish as standard software engineering practice the use of defined processes for the management and development of software and to advance the capabilities required to define the software process within an organization. The SPD Project supports process improvement through the development and maturation of methods and technology that support process definition.

The project is supporting process development efforts with SSC, Gunter AFB, and Army Materiel Command (AMC). The project is also exploring advanced applications of process through the Software Technology for Adaptable, Reliable Systems (STARS) Program.

During this period, the project continued to support the efforts of the Software Development Management Policy process action team at SSC. This process action team was chartered to develop new management policy for SSC that covers the policies and infrastructure required for an organization operating at SEI capability maturity model (CMM) repeatable level (Level 2).

Project members delivered an annotated version of the software process definition Workshop, *Defining the Software Process: Getting Started*. The workshop is designed to:

- Introduce software process management principles and terminology.
- Discuss the role of process definition in the improvement cycle.
- Introduce process definition terminology.

- Provide assistance with methods and techniques for defining current as-practiced processes.
- Provide participants with skills required to define software processes.

The project also delivered a process framework based on the SEI CMM. The CMM Process Framework provides guidance in identifying the policies, processes, and procedures that are supportive of the CMM repeatable level. The framework provides criteria that an organization can use to review their software policies, processes, and procedures to determine if they are supportive of the CMM. The framework also provides information that can be used to develop software policies, processes, and procedures that are supportive of the CMM.

The project is providing support to the Missile Command (MICOM) / Life Cycle Software Engineering Center (LCSEC) and Armament Munitions and Chemical Command (AMCCOM)/LCSEC. During this quarter, the project begin planning support for Software Engineering Process Groups (SEPGs) that are being formed at MICOM and AMCCOM. The project also established an initial schedule for delivery of the software process definition workshop.

The project is providing support to the Defense Advanced Research Projects Agency (DARPA)/STARS effort as technical lead for the DARPA/STARS Process Asset Library (PAL). This is a joint effort between the SEI and STARS prime contractors. The effort is also supported by SEI resident affiliates from American Telephone and Telegraph (AT&T), and General Telephone Electronics.

During this period, the project initiated the development of Version 2.0 of a prototype Process Asset Library (PAL) V2.0. This version of the PAL will extend existing assets to include process guides for each process model. Additional assets will also be created and added to the PAL.

During this period, the project initiated the development of the document *Process Specification Standards and Guidelines*. This document describes an elaborated set of standards and guidelines for developing process assets for the STARS PAL. Topics include:

- Information requirements for defining software processes.
- Guidelines for defining, tailoring, and planning the use of software processes.
- A generalized framework for classifying types of processes.

The Capability Maturity Model (CMM) Project maintains a model describing how organizations can improve their software process maturity. This model will be continuously updated with the state of the art as it evolves in software engineering, total quality management, and other relevant areas of improvement. It will elaborate on software development practices that provide clear strategies for capability maturity growth and improvement.

CMM V1.01 was drafted and shipped to the CMM Correspondence Group for review at the beginning of September. CMM V1.02 is scheduled to be drafted by early October.

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**Capability Maturity
Model**

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Empirical Methods

The Empirical Methods Project develops, evaluates, and validates products (e.g., questionnaires and tests, methods, and models) for use in baselining and measuring software process improvement.

Project staff and colleagues from the Capability Maturity Model (CMM) Project, Software Process Assessment (SPA) Project, Products and Services Planning, and Information Management at the SEI developed initial prototypes of the CMM-based process maturity questionnaire and related questionnaire prototypes for use in pilot testing during 1992. Initial usability testing of the maturity questionnaire occurred in June. Using prototypes that benefitted from all previous usability testing, several current or recently departed SEI resident affiliates are collecting maturity questionnaire usability data during September and October. This effort supports the SEI team's testing of questionnaire prototypes in several industry and government organizations to improve the clarity and usability of the updated process maturity questionnaire. Also, Empirical Methods will be working with SPA Associates in questionnaire pilot tests.

An SEI team lead by Empirical Methods is developing questionnaires for use in capturing consistent information to determine the scope of SPAs and SCEs, to help with selecting projects to include in a SPA or SCE and to collect information about the people completing the maturity questionnaire for use in efficient planning of the on-site period for SPAs and SCEs. Prototypes of these auxiliary questionnaires, the V1.1 Maturity Questionnaire, and the prototype rating method will be released together for beta testing.

Empirical Methods and the CMM Project are collaborating with a resident affiliate from Pacific Bell to prototype an "instant profile" product. Exploration of joint product development work with industry and government members of the process improvement community began in February and is ongoing.

A special report summarizing participants' evaluation of the Software Engineering Process Group (SEPG) Workshop and characterizing SEPGs will be available early in the next quarter. This report will be distributed initially to those workshop participants who provided data to the SEI by completing forms at the 1992 SEPG Workshop held at Tysons Corner, Virginia.

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**Software Process
Reports**

July—September 1992

Software Measurement for DoD Systems: Recommendations for Initial Core Measures
(CMU/SEI-92-TR-19)

Software Size Measurement: A Framework for Counting Source Statements
(CMU/SEI-92-TR-20)

Software Effort and Schedule Measurement: A Framework for Counting Staff-Hours and Reporting Schedule Information
(CMU/SEI-92-TR-21)

Software Quality Measurement: A Framework for Counting Problems and Defects
(CMU/SEI-92-TR-22)

A Concept Study for a National Software Engineering Database
(CMU/SEI-92-TR-23)

An Analysis of SEI Software Process Assessment Results 1987-1991
(CMU/SEI-92-TR-24)

Software Measures and the Capability Maturity Model
(CMU/SEI-92-TR-25)

*Software Engineering Process Groups: Results of the 1992 SEPG Workshop Event
Evaluation and a First Report on SEPG Status*
(CMU/SEI-92-SR-13)

For information about ordering copies of SEI reports, see page 37.

Real-Time Distributed Systems

The goal of the Real-Time Systems Program is to improve the development of real-time distributed systems by integrating software engineering with systems engineering and reducing the risk associated with new technology.

The Rate Monotonic Analysis for Real-Time Systems (RMARTS) Project aims to ensure that rate monotonic analysis (RMA) and scheduling algorithms become part of the standard practice for designing, building, troubleshooting, and maintaining real-time systems. RMA helps engineers to understand and predict the timing behavior of hard real-time systems to a degree not previously possible.

Project members continue to work within the portable operating system interface standard (POSIX) community to assure that Navy Next Generation Computer Resources (NGCR) requirements are met. At previous POSIX meetings, project members met with the 1003.12 group, which is concerned with protocol-independent interfaces for interprocessor communication. However, the project felt that real-time needs would be better met by becoming a separate working group in POSIX. Therefore, project members have prepared and submitted a project authorization request and supporting materials. A meeting took place in September, hosted by Parama, in Minneapolis.

Project members are supporting the prototyping effort for the Ada binding to the NGCR lightweight services, intended for use in the real-time domain. The project hosted a member of the Computer Networks Laboratory at the University of Virginia who is implementing the prototype. During a two-week stay at the SEI, project members clarified questions about the interface semantics and addressed the interaction between the Ada runtime and the UNIX operating system. Several interesting performance issues have been identified about the use of UNIX in the real-time domain.

Project members continue to interact with members of the Master of Software Engineering (MSE) Program at Carnegie Mellon University (CMU). Project members are serving as a customer for a studio project that is developing a real-time analysis toolset. The purpose of this tool is to enable the user to develop a schedulability analysis of a task set that includes the effect of the runtime system in a portable manner. In a second area, an MSE student is taking a reading course in real-time systems with an orientation toward schedulability considerations.

Project members have been asked to develop course materials in the area of open systems architectures, including procurement aspects. This request is in support of a pending TO&P contract.

Project members continued working toward the long-range goal of producing a real-time systems engineering handbook. The goal of the handbook is to codify the principles of RMA in a manner that is easily accessible to real-time systems practitioners. The core of the handbook is a structured collection of real-time situations—small, self-contained modules of information about RMA.

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**Rate Monotonic
Analysis for
Real-Time
Systems**

Work on the handbook has proceeded through an evolution of drafts, each with a different focus. The focus of the draft released in May 1992 was to finalize the structure of the handbook so that individuals other than the primary authors could contribute text. This version facilitated a substantial contribution from a contributor who had formerly been a visiting scientist with the project.

The beta version of the handbook was completed in August 1992. The focus of the Beta version of the handbook was to develop realistic case studies that illustrate how to apply the RMA principles that are described in the rest of the handbook to realistically complex systems. This draft includes two case studies—one that shows how to use RMA to analyze a real-time system, and one that shows how to use the principles of RMA to guide the design of a real-time system. In addition to adding the case studies to the handbook, project members added several new real-time situations and techniques that were needed to explicate the case studies.

This quarter, the RMA handbook team began distributing the beta version. The team sent awareness letters to more than 400 people, whose names came from lists of attendees at various Rate Monotonic Analysis for Real-Time Systems (RMARTS) and real-time events. The letter included a response form for requesting a copy of the handbook. Between the awareness letter, an announcement that appeared in the June issue of *Bridge*, personal contacts with project members, and requests during the SEI Software Engineering Symposium, the project has received requests for 350 copies of the Beta version.

Project members held a review session for the beta version during the evening of the final day of the SEI symposium. About 20 reviewers from user companies, government acquisition agencies, vendor companies, and research organizations participated in this focus-group review session. The participants recommended changes and additions to the current version, and the handbook team reviewed plans for completing the handbook by early next year. The review group commended the value and usability of the handbook, but they also expressed that the handbook needs to provide more guidance about the use of RMA in multiprocessor environments.

The focus of the final draft of the handbook will be to complete additional real-time situations that show how to apply the principles of RMA to areas, such as multiprocessor environments, that are of concern to real-time systems practitioners. The team is making progress in writing these real-time situations.

Project members presented a half-day tutorial on RMA management practices at the Washington Ada Symposium (WAdaS). One of the attendees told the presenters that her company had recently responded to a request for proposals (RFP) for the On-Board Electronic Warfare Simulator, which required that RMA be used to ensure task schedulability. This is the first example of an RFP that mandates the use of RMA.

In addition to the management tutorial, Lee Lucas and Keith Kohout of the Naval Air Warfare Center - Weapons Division, at China Lake, presented a full-day rate monotonic analysis and scheduling tutorial at WAdaS. They are scheduled for a full-day tutorial at Tri-Ada 1992 as well.

Telos and Tri-Pacific, the two pilot RMA training firms, participated as exhibitors in the SEI Symposium, where they showcased their new RMA courses. Their course descriptions were also included in the SEI products and services portfolio, which was distributed to all symposium attendees.

The project held a one-day RMA users forum in conjunction with the SEI symposium. Attending the users forum were more than 55 participants from various user communities: representatives from government, both DoD and National Aeronautics and Space Administration (NASA); government-contracting and commercial developers; software and service vendors; and RMA and real-time researchers. This event was intended to be a first step in the formation of a community interested in continuing the transition and extension of RMA and its principles after the RMARTS Project at the SEI has completed its work.

The project began drafting a memorandum of understanding with the Software Productivity Consortium (SPC) to provide support to the SPC effort to incorporate RMA into their Ada-based design approach for real-time systems software design method. The plan is for the SPC to research and document findings, with the RMARTS Project providing review support.

Ruth Ravenel of the University of Colorado at Boulder visited the SEI and reviewed RMA and the RMA tutorial with various project members. Ravenel offers computer engineering courses at the university, which are televised and viewed by engineers at various company sites in the area. She is developing a videotape to serve as a short course on RMA. The videotape will be packaged along with course notes and exercises and targeted toward university professors. Professors will be able to use the package as a two- or three-class module in a real-time curriculum. The SEI plans to include Ravenel's videotape in the SEI Technology Series. It will be available to universities, as well as government and industry, for instructional use.

Project members visited Booz-Allen and Vitro, both of which provide independent verification and validation (IV&V) support to development projects. The purpose of these meetings was to discuss the role of RMA in IV&V. The SEI objective is to find potential agents for transitioning RMA management practices, paralleling vendor distribution of RMA training, and technical consulting. Booz-Allen, in particular, expressed interest in adopting RMA; representatives of Booz-Allen also attended the users forum.

The Real-Time Embedded Systems Testbed (REST) Project collects, classifies, generates, and disseminates information about Ada performance in hard real-time embedded systems.

Building real-time systems, particularly embedded and distributed real-time systems, is currently a craft rather than a structured, methodical endeavor. Tools, including the Ada programming language and the accompanying Ada runtime support facilities, are only beginning to fulfill their promise for raising the level of abstraction for real-time programming. Use of such tools is still perceived as entailing many risks. The REST Project identifies and helps reduce such risks.

At this time, the government does not routinely assess the quality of Ada compilation systems. Both Ada users and vendors need help to improve the quality of such systems. The REST Project identifies, develops, and distributes techniques and tools to improve Ada implementations.

The project developed the Hartstone benchmarks as a set of timing requirements for testing a system's ability to handle hard real-time applications. These benchmarks are specified as a set of processes with well-defined workloads and timing requirements. The name "Hartstone" is derived from the phrase "hard real-time" as well as from the fact that the

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**Real-Time Embedded
Systems Testbed**

workloads are based on the Whetstone benchmarks. Five test series of increasing complexity have been proposed for Hartstone. The first of these, the periodic harmonic (PH) series, has been implemented in Ada.

This quarter, the project continued work on Hartstone by experimenting with several implementations of the periodic nonharmonic (PN) benchmark, the next program in the series. A workshop was organized in June 1992 to report on the project's progress and obtain feedback from the user community. As a result, the project revised its original schedule. Minor discrepancies with the PH series were corrected and the Hartstone code was restructured to enable a debugger to be used as an interactive interface for the tailoring of parameters and for performing multiple Hartstone experiments. This eliminated the need for repeated compile/link/download cycles when running the benchmark, and it also facilitated experimentations with nonharmonic task sets. This PH/PN version was sent to beta test sites in September 1992. In accordance with recommendations made at the workshop, the project is now working on the aperiodic version of the series (AH).

In support of BSY-2, the project also investigated the performance impact of Ada style using the U.S. Ada compiler evaluation capability (ACEC), the U.K. Ada evaluation system (AES), and Performance Issues Working Group (PIWG) assessment software. A document was delivered to the U.S. Navy that uses the results of these benchmarks to improve the BSY-2 Ada style from a performance standpoint. In the light of this experience, the project continued to cooperate with the Wright Avionics Lab at Wright-Patterson AFB in the review of the proposed merger of the ACEC and the AES.

Project members actively participated in the work of the Association for Computing Machinery (ACM) Special Interest Group for Ada (SIGAda) Ada Runtime Environment Working Group (ARTEWG) and PIWG. These activities support the Ada 9x process, focusing on the needs of the Ada real-time community.

The project continued to develop an online copy of major references in the field with the goal of regularly producing annotated bibliographies and selected papers publications in 1993. The RMARTS and REST Projects intensified their cooperation in the development of benchmarks necessary for the rate monotonic analysis of real-time system software, as well as guidelines for the creation of such benchmarks.

In this quarter, the project began cooperating with Professor Daniel Sieworek at CMU in the implementation of Ada benchmarks to measure system robustness. A student of Professor Sieworek is now routinely using the testbed, mostly from CMU, by using the remote control features previously implemented by Gene Rindels.

In an effort to present REST technology in a form that better appeals to managers, the project led a small team of experts from the SEI Process, Education, and Methods Programs in the definition of real-time extensions to the CMM. This effort prototyped several approaches and generated a list of more than 100 technical practices. The status of this exploratory work was presented at the 1992 SEI Software Engineering Symposium.

• • • • • Real-Time Simulators

Real-time simulators, especially flight simulators, have traditionally used a software architecture that is optimized for efficiency. The focus on efficiency has complicated the achievement of certain types of functionality and has caused severe problems in maintainability and modifiability. Understanding the design tradeoffs involved in

emphasizing certain non-functional qualities will enable designers to develop model software architectures that satisfy these qualities, thereby improving the process of developing real-time simulators.

The goals of the Real-Time Simulators Project are to:

- Extend, validate, and document flight simulator and other real-time simulator architectures in a form accessible to practitioners and acquisition personnel.
- Understand and codify the relationship between non-functional quality goals and simulator software architectures.

This quarter, project members completed and delivered an annotated outline of a guidebook on the air vehicle portion of flight simulators. The guidebook will contain 20 chapters and a number of appendices. The appendices will contain examples produced from the development of the T39A trainer. The guidebook itself will be produced during 1993.

The project has begun working for STRICOM to prepare for upcoming support to the Close Combat Tactical Trainer system. The support of this system will enable the project to explore design methodologies in a different context than flight simulators.

The Systems Fault Tolerance Project is investigating the use of fault tolerance in the design and implementation of dependable or critical systems.

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**Systems Fault
Tolerance**

The System Fault Tolerance Project is playing a major role in the formation of the Software Dependability Working Group (SDWG), an advisory group that will be drawn from industry, university researchers, and government personnel. The first activity of the group will be to convene a series of technology exchange workshops. The workshops will bring together researchers (those with solutions to problems) and practitioners (those with "real" problems that meet multiple constraints with integrated solutions). During this workshop, technology transfer is expected to be a two-way process; technology users will learn about software technology that may apply to their dependability needs and technology sources will learn much from technology users about the constraints and needs of their respective application domains. The initial technology transfer workshop will be aimed at experienced practitioners and it will be followed by a planning workshop to determine the major technology components and to develop a plan for their transfer. After the workshop, a selected group will draft the SDWG charter.

This quarter, project members organized a panel discussion on the state of the practice of fault tolerant systems at the 22nd Institute of Electrical and Electronic Engineers, Inc (IEEE) International Fault Tolerant Computing Symposium in July. Panelists discussed their experiences in implementing control systems at Asea Brown-Boveri in Switzerland, flight-critical systems at Honeywell, commercial fault tolerant computers at Sequoia, safety-critical controls systems at Triconex, space systems at Martin-Marietta, and transport signalling and control systems at Hitachi in Japan.

The Systems Fault Tolerance Project is collaborating with members of the Electrical and Computer Engineering Department and with the School of Computer Science at CMU in working on Fault Tolerant Mach. The status of this collaboration was presented at the summer meeting of the IFIP Working Group 10.4 on Dependable Computing.

Because of the importance of fault tolerance in the development of software for safety critical applications, project members participated in the SIGADA Ada Run-Time Environment Working Group meeting to discuss software for safety-critical applications. Project members also attended a subcommittee meeting of the U.S. Nuclear Regulatory Commission Advisory Committee to discuss reactor safety concerned with software development for nuclear applications.

• • • • • Transition Models

The Transition Models Project is developing a set of methods and supporting materials such as guidelines and checklists for planning, implementing, and assessing transition activities. These materials will be used by software technology producers and consumers both inside and outside the SEI. Transition Models staff also provides other SEI staff, including management, with education and training on technology transition concepts and approaches. Additionally, project members provide limited consulting on software technology transition to members of the SEI constituencies, and maintain contact with researchers and others interested in technology transition from business and academic domains.

In July, Priscilla Fowler and Albert Soule met with the Senior Economist in the Office of Productivity, Technology, and Innovation (Department of Commerce) to discuss models of concurrent technology transition involving commercial enterprise.

Fowler and Linda Levine participated in meetings at the SEI with Joe Maranzana of AT&T to discuss the AT&T technology transition approaches that are used for improving software development technology.

During the recent International Federation of Information Processing (IFIP) World Congress, Transition Models project members proposed an international working group on technology transfer that would operate under the aegis of IFIP. Meetings were held with Technical Committee (TC) 8 (Information Systems) and the IFIP Technical Assembly. Approval was given for TC 8 to begin work toward a working conference on the topic of information technology transfer. Project members will consider the advantages of hosting the conference in 1993 at the SEI.

Project members presented "RMA: A Case Study of the Transition of a Software Technology," and participated in technical interchange meetings at the Universidad Politecnica de Madrid in conjunction with their attendance at the IFIP Congress. Meetings were also held with faculty of the Universidad de Navarra, a leading business school in Spain, to discuss approaches to the transfer of software and other process-intensive technologies.

Project members reviewed a draft guidebook on technology transition that is being prepared by the SPC. Also this quarter, educational objectives were met with a tutorial for the SEI Risk Program, and the continuing meetings of the discussion group for technology transition.

The project continued to collaborate with Natalia Juristo, a resident affiliate from the Universidad Politecnica de Madrid, to study the feasibility of a small expert system to assist with technology transition planning. A memorandum of understanding describes how the work will continue after Juristo leaves the SEI in September.

In September Fowler presented "Prognosis for a Discipline of Software Technology Transition," at the SEI Symposium.

The objective of the Zero-Defect Application Kernel Project is to develop and transition software fault tolerance methodology for real-time mission-critical systems. Project members are generalizing the rate monotonic scheduling theory and developing software fault tolerance methods using analytic redundancy. The project will combine them into a unified software engineering framework for practitioners who must meet both real-time and fault tolerance requirements.

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**Zero-Defect Application
Kernel**

In a wide area network, distributed scheduling decisions must be made with incomplete and delayed information. Project members have developed the theory and protocols to achieve coherency and predictability in scheduling real-time communication over wide area dual-link networks. Based on this theory, project members have written a paper that suggests modifications to the IEEE 802.6 Wide Area Network Standard. The modifications would make the standard more suitable for real-time communication. The paper, "Scheduling Real-Time Traffic on Dual-Link Networks" by Sha, Shirish, and Strosnider, received one of the highest scores (6.33 out of a possible 7) in the 13th IEEE Real-Time System Symposium.

In software fault tolerance, project members have signed a cooperative agreement with MITRE, who is providing full support for us to conduct a series of proof-of-concept experiments at the MITRE facility. A paper—written by members of the SEI, CMU, and MITRE communities—describes the project's approach to software fault tolerance in surveillance systems. The paper, "Responsive Airborne Radar Systems," will appear in the *Proceedings of the Second International Workshop On Responsive Systems*.

The NASA Space Station Advisory Committee has asked Sha to join its data management subcommittee and review operations by Johnson Space Center, Marshall Space Flight Center, and the Draper Lab.

Analysis of Reservation-Based Dual-Link Networks for Real-Time Application
(CMU/SEI-92-TR-10)

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**Real-Time
Distributed
Systems Reports**

For information about ordering copies of SEI reports, see page 37.

July—September 1992

Software Engineering Techniques

The goal of the Software Engineering Techniques Program is to increase the use of engineering knowledge for effective and efficient production of large software-intensive systems through a model-based software engineering approach and engineered project support environments.

The program recently reorganized to integrate SEI technical work with a common technical vision and strategy. The CASE Technology Project and the Software Development Environments Project were consolidated into the CASE Environments Project to address issues of engineering of environments. The Domain Analysis Project and the Software Architectures Engineering Project were consolidated into the Application of Software Models Project to address the systematic creation and application of models in application engineering. The Advanced Video Technology for Imaging Project, the Requirements Engineering Project, and the Software Architecture Design Principles Project were consolidated into the Software Engineering Information Modeling Project to address issues of capturing, representing, and making accessible increasing amounts of engineering information ranging from requirements to engineering knowledge typically found in handbooks.

The Domain Analysis Project and the Software Architectures Engineering Project were consolidated into the Application of Software Models Project to address the systematic creation and application of models in application engineering.

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**Application of Software
Models**

During this quarter, project members completed a tutorial for the Conference on Software Engineering Education. The tutorial, developed jointly with the Air Force Institute of Technology, is entitled "Putting the Engineering into Software Engineering." Sections of this tutorial will be used at TRI-Ada in November.

Project members have considered a means to support the maturing and transition of the Message Translation and Validation (MTV) work. Several outside organizations, both government and industry, have expressed an interest in the use of MTV, and project members are currently preparing a report defining the current status of MTV and plans for turning it into a product. One element of such a product would be a training course in the use of MTV.

During this quarter, the project reviewed the Joint Modeling and Simulation System (J-MASS) Simulation Support Environment and determined ways in which the SEI can support development of the environment under the project's TO&P agreement. The area of primary interest is the simulation executive. Together with Major Bailor, who was a visiting scientist at the SEI during August and September, the project drafted a technical paper describing the design of the executive under the Object Connection Update model.

During the third quarter, project members completed the initial version of several demonstration reusable software packages for movement control. These packages, which will support convoy building and route planning, have been tested in an integrated system demo and have been delivered to Communications-Electronic Command (CECOM) as part of a TO&P deliverable. Staff at the CECOM Software Engineering Directorate will now rehost this software to the Army Tactical Command and Control System (ATCCS) common hardware and software for implementing movement control throughout the ATCCS system. To continue this transition effort, the project will work with General Electric (GE) and MITRE, two other developers of ATCCS common software.

During the SEI Software Engineering Symposium in September, project members presented a project update to Lieutenant General Peter Kind, the new director of Information Systems for Command, Control, Communications, and Computers (DISC4). General Kind was the original sponsor of this work when he was the Program Executive Officer (PEO) for Army Command and Control Systems. He stated that the work appeared to very useful and urged that the project concentrate on identifying ways to deliver improved products to the end user, the soldier in the field. Project members also presented a project overview and demonstrations to other DISC4 personnel who have asked for the project's assistance in supporting part of their reuse effort.

During this quarter, the project continued to support the Navy Coastal Systems Station (CSS) Architecture Working Group. Project members have updated the Combat System Integrated Training Equipment Product Models document—specifically those portions that document architectural elements for subsystems—hardware interfaces, and the executive. Project members have also reviewed the CSS Scenario Controller. During September, the project supported a preliminary design review (PDR) and produced minutes of the PDR, plus a critique of some elements of the design.

This quarter, a project member gave a presentation to the Nuclear Regulatory Commission (NRC). The focus of the lecture was engineering issues that can support safety critical systems to the NRC. Also, a project member presented a overview of the project and ways in which the project might contribute to the National Security Agency reuse activities through a proposed TO&P.

Also this quarter, a project member provided a program overview describing project accomplishments and plans at the SEI Symposium.

● ● ● ● ● ● ● ● ● ● CASE Environments

The CASE Environments Project addresses this problem: while a large number of software tools and integrating frameworks are currently available, generally there is not clear evidence to determine the precise impact of those tools on productivity and quality. In addition, the integration of different tools is problematic, and the organizational issues for the adoption of technology and the support of tools for an organization's software development process are not well understood or generally agreed upon.

This overall problem is addressed through three general approaches:

- Developing conceptual frameworks to understand tool integration and tool adoption from the perspectives of technical mechanisms, users services, and organizational processes.

- Viewing both integration and adoption as design activities that require an analysis of the current state and a coherent process to move to a desired state.
- Verifying the conceptual frameworks through small-scale experiments.

The CASE Technology Project has three major task areas:

- Environment support for configuration management.
- Environment support for integration.
- Computer-aided software engineering (CASE) adoption.

This quarter, project members have identified the state of commercial technology regarding software configuration management (SCM) support. This has been captured through a spectrum of concepts and paradigms. Configuration management (CM) capabilities can be found in SCM tools, CASE tools, and environment frameworks, each implementing its own variant of some of the concepts. This variety leads to the need to integrate tools with different SCM capabilities into a software development environment, and the desire for a unified SCM model that can be adapted to different processes. The result is project activity in issues of consolidation of SCM concepts, integration of SCM and CASE tools, and SCM support for the CM process and its relationship to the CMM. In the SCM area, the results are communicated through articles, presentations, and tutorials. In particular, a paper describing aspects of project work on understanding the state of the art in SCM was presented at the IFIP World Congress in Madrid.

The need for integration of SCM and CASE and a number of emerging environment technologies has led to increased project activity on environment architectures in support of integration. A number of government and industry efforts are focused on environment reference models and interface standardization. New insights are gained into the problem of environment integration, taking into consideration environment framework mechanisms, engineering service concepts and information models, and engineering processes. The project presented these ideas at several forums in August, including CASE '92 and the SEI Software Engineering Symposium.

The Software Engineering Information Modeling Project was formed from the Requirements Engineering, Advanced Video Techniques for Imaging, and Software Architecture Design Principles Projects, and is building on their results and activities. The consolidation of these projects into a single project will permit a more integrated approach to identifying solutions to a common set of problems. In particular the creation, maintenance, and use of models is critical to software engineering. Thus, readily accessible software engineering information, knowledge, and models that are reusable can facilitate the development of software-dependent systems.

The project is investigating techniques and tools to improve the software engineer's ability to capture, represent, and access reusable software engineering information, knowledge, and models. Plans have been developed to pilot technology that facilitates access to software engineering information, initially focusing on the improvement of requirements capture and analysis.

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**Software Engineering
 Information Modeling**

This quarter, project members have worked with the Naval Supply Systems Command to refine a statement of work entitled "Research and Development of Advanced Technology in Support of the NAVSUP."

Project members initiated work in the area of requirements elicitation with the requirements writers and developers of the Army Highway Operations System (HOS). To effect a high-quality process, an intra-project workshop on current elicitation strategies and techniques and the problems in the field was held. The project held an initial interview with the requirements writers and developers of the HOS in Virginia, followed by a formal elicitation held in July. The goal of this process was to analyze the context of the HOS and determine the boundaries of the system to be developed. The domain models for movement control, created by the Application of Software Models (ASM) Project, were examined for their applicability to the context analysis activity. A member of the ASM Project participated in the July meeting so that future areas of collaborative work between the projects could be identified. This context analysis meeting was videotaped, so that the project would have multiple representations of system information. These multiple representations (including video transcripts, text notes, a series of context diagrams, and a number of operational scenarios) are now available as a source of data for examining the context analysis process.

This quarter, the project leader was an invited panel member and presented a paper on multimedia operating system requirements at the Fourth International Conference on Software Engineering and Knowledge Engineering. The project leader gave a keynote address, "Digital Video Design," at the Slice of Life Medical Multimedia Database Workshop in Salt Lake City. The project leader also presented a paper on modeling information visualization knowledge at the American Association for Artificial Intelligence annual meeting.

Invited talks given by project members included a keynote address, "The Role of Visual Fidelity in Computer-Based Instruction: Why Bother with Motion Video and Realistic Interfaces?" at the Slice of Life Medical Multimedia Database Workshop in Salt Lake City, Utah; and "Interface, Fidelity, and Development Issues in a Virtual Reality Workspace for Software Engineering" at the Sixth Autumn School on Man Machine Interaction in Jouy-en-Josas, France, sponsored by Campus Thomson and Institut de l'École Normale Supérieure.

The project leader and a project member published papers this quarter including "Next Generation Network and Operating System Requirements for Continuous Time Media," in *Network and Operating System Support for Digital Audio and Video*; "Virtual Reality on a PC," in *Instructional Delivery Systems*; and "Viewpoint: Time Traveler," which is a critique of 3-dimensional virtual reality design issues.

The project leader has also been appointed Vice-Chair of the IEEE Task Force on Multimedia Computing.

The Past, Present, and Future of Configuration Management
(CMU/SEI-92-TR-8)

Software Measurement Concepts for Acquisition Program Managers
(CMU/SEI-92-TR-11)

Issues in Requirements Elicitation
(CMU/SEI-92-TR-12)

A Classification and Bibliography of Software Prototyping
(CMU/SEI-92-TR-13)

Experience With a Course on Architectures for Software Systems
(CMU/SEI-92-TR-17)

A Bibliography of Externally Published Works by the SEI Engineering Techniques Program
(CMU/SEI-92-SR-23)

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**Software
Engineering
Techniques
Reports**

July—September

For information about ordering copies of SEI reports, see page 37.

Special Projects

The Binding of Ada and SQL Project, initiated at the request of the Ada Joint Program Office, has investigated the problem of binding the Ada programming language with the Structured Query Language (SQL) database language. The solution to this problem was the specification of the SQL Ada Module Extension (SAME), an interface that permits an application program written in Ada to access and manipulate data that is controlled by a database management system (DBMS) using SQL.

..... Binding of Ada and SQL

During this quarter, Sub Committee 22 of the International Standards Organization, the parent body of Working Group 9, accepted the SQL Ada Module Description Language (SAMEDL) Reference Manual as a Committee Draft. This begins the process of authorizing the manual as a Draft International Standard. Copies of the Reference Manual were forwarded to officers of the Database Committee (X3H2) of the American National Standards Institute to be forwarded to the committee members. The project leader will attend an X3H2 meeting during the upcoming quarter.

Two commercial implementations of the SAMEDL appeared this quarter. They are products of Intermetrics Inc., of Cambridge, Massachusetts, and Competence Center Informatik (CCI) of Meppen, Germany. The project received a copy of the CCI compiler. Computer Associates contacted the project concerning implementation of the SAMEDL. (Computer Associates began an implementation earlier.)

Statistica Inc., a supplier of management information systems to the government and, in particular, prime contractor on Army personnel systems, SIDPERS-3, announced privately that they are preparing two series of educational seminars on SAMEDL: one for managers and one for programmers. The Ada SQL Project will be cooperating with their efforts.

The Process Research Project investigates the factors that limit software development performance by conducting research on the use of software process principles by individuals and small teams. This research is seeking insight into the processes, tools, and methods that will be most helpful in improving the performance of software engineering professionals.

..... Process Research

During this quarter, the principal focus was on better defining design methods for personal use. The methods were defined then tested during the development of four C++ programs. While additional refinement is required, the results to date appear promising.

The project has now completed 26 C++ programs, and program #27 is nearing completion. The total lines of code produced to date are 5900 with 4091 new and changed lines for a reuse ratio of 30.7%. The most recent four programs, using the newly developed design methods, have achieved a reuse of 46.2%, and program #27 is expected to have a reuse ratio of 56.3%.

The early transition efforts for this project are concentrating on finding potential groups that will provide additional research data on the method's effectiveness as well as early insight into the issues of applying these methods in industrial environments. Not surprisingly, the groups worked with to date, while very interested, are very slow to actually get started in using the methods. Much more work is required in this area, and it will be an increasing focus of the project in the future.

Other project activities during the quarter included giving a talk at the Washington Ada conference, and one at the Hewlett Packard annual software conference. The project leader also gave the keynote address to the Information Systems track of the Project Management Institute annual meeting.

This quarter, the SEI technical report entitled *Introduction to Software Process Improvement* (CMU/SEI-92-TR-7) was published. This report explains why some of the historical software problems have been difficult for organizations to address and the actions required to address them. It describes the SEI software process maturity model, how this model can be used to guide software organizations in process improvement, and some guidelines that organizations have found helpful in their improvement efforts. The report concludes with a discussion of the most common process improvements traps and pitfalls, and the steps to take to avoid them.

The SEI technical report *Software Process Development and Enactment: Concepts and Definitions* (CMU/SEI-92-TR-4) was completed jointly with Peter Feiler of the Engineering Techniques Program. This report defines a core set of concepts about the software process. These concepts are intended to facilitate communications and to provide a framework for further definitions. The definitions focus on essential concepts; however, they do not represent a comprehensive glossary of common software process terms. Following an initial overview, this report outlines the basic process concepts that underlie the definitions. The definitions are then grouped in four sets: a framework for process definition, an engineering of process, an enactment of process, and process properties. This is followed by illustrations of the use of these concepts in several domains. The report concludes with some observations on the definition process.

A study on software product liability has been completed with a professor at the School of Law at the University of Pittsburgh, and a draft paper has been written that summarizes the results.

During this quarter, the project leader participated in an Air Force Science Advisory Board review of the Standard Systems Center at Gunter AFB. These reviews are held annually at the request of General Fairchild.

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Special Projects Reports

July—September 1992

Software Process Development and Enactment: Concepts and Definitions
(CMU/SEI-92-TR-4)

Introduction to Software Process Improvement
(CMU/SEI-92-TR-7)

The Domain-Specific Software Architecture Program
(CMU/SEI-92-SR-9)

For information about ordering copies of SEI reports, see page 37.

Software Risk Management

The Risk Program is exploring existing techniques and developing methods for managing risk, assessing practice, preparing organizations to manage risk, and conducting prototype risk assessment methods. To achieve its goals and objectives, the Risk Program must not only provide the mechanisms for managing risk, but must also provide a process that can be implemented within a project and organization to facilitate the communication of risk issues. Communicating risk underlies the strategy of addressing risk throughout the acquisition process and strengthening the relationship between government and industry. The program reorganized in July into three projects to emphasize its close customer relationships: the Government Risk Management Project, the Industrial Risk Management Project, and the Risk Taxonomy Project.

The Government Risk Management Project provides the primary interface to government customers and establishes collaborative partnerships for developing risk management methods. It develops and conducts interviews, risk assessments, risk assessment training, and risk profiles. Risk management methods are improved through active field work with government and industry defense programs. The project is developing methods with primary focus on helping the government program manager manage risk, particularly in the framework of the acquisition life cycle. The project will develop methods to facilitate and strengthen risk communication through a rational, visible structure for identifying and analyzing risk. This project is concerned with creating viable methods for communicating risks internally within programs, which includes the communication of risk between the government and the contractor and externally to higher levels of management.

This quarter, project members initiated project planning that focuses on government risk management and closer working relationships with industry partners. During this quarter, project members signed an agreement with the National Oceanographic and Atmospheric Agency to conduct a risk assessment with potential follow-on collaborative work. Project members also presented the plan for the "Expert Review" method of development to Barry Boehm and others from the Software Action Plan Working Group.

During this quarter, project members conducted three interviews (#4, #5, and #6) with the Navy and drafted a state-of-the-practice presentation. This completed the project's interview deliverable according to schedule. Project members also conducted an executive risk management orientation session with PEO(A) Navy executives and program managers.

Project members also conducted a risk assessment orientation with Navy PEO(A) and the Naval Air Systems Team. These orientations and the Navy interviews completed the project's TO&P 2-145 deliveries on schedule.

This quarter, the project hosted the Naval Air Systems Team Software Quality Management Board.

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**Industrial Risk
Management**

The goal of the Industrial Risk Management (IRM) Project is to develop, demonstrate, and transition risk management processes and techniques to an industrial client base. The project intends to fulfill its mission by working with industry partners to demonstrate methods of risk identification—the first step in risk management—and then to develop the succeeding risk management steps with a small number of strategic industry partners who are likely to be successful in transitioning software risk management into wide use on their projects.

This quarter, the project members drafted a joint plan with the client for industry risk assessment #3 (completed in June 1992) to become a strategic partner of the IRM Project that will support the use of the SEI and the client's methods for managing the risks identified in the risk assessment.

Project members also developed a mission statement, tactics, and an initial set of task plans to accomplish its part of the Risk Program objectives.

This quarter, meetings took place between project members and a potential industry strategic partner of the SEI. The result of the meeting was a draft of an informal agreement that contains a statement of joint work with the IRM Project.

Project members delivered a presentation on the state of the practice in risk management and chaired a panel session on practitioners' views of software risk management at the SEI symposium. Project members also delivered the executive briefing to initiate industry risk assessment #4 and agreed on the schedule for the assessment.

During the third quarter, project members developed a strategy to work with selected industry partners to deliver risk assessments, to transition risk assessment methods to them, and to develop risk management techniques with them. Also this quarter, project members gave a presentation that focused on the state of the practice in risk management. This presentation was made at the Software Process Improvement Network meeting that took place in California during September.

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Risk Taxonomy

The Risk Taxonomy Project is refining the taxonomy-based questionnaire to: 1) identify software technical risk, and 2) be easily used by development organizations. The strategy of the Taxonomy Project is to derive a software risk taxonomy by analyzing risk assessment data and other related literature; field test the taxonomy-based questionnaire; and modify the questionnaire based upon field test data. In addition to developing the taxonomy-based questionnaire, the Risk Taxonomy Project is developing analytical methods to quantify the risks identified by the taxonomy-based questionnaire. These analytical methods were integrated into the field test activities on field test #2.

A computational approach to the development of the taxonomy is being done through the analysis of risk assessment data through natural language processing. The software used is the CS Project software in the Laboratory for Computational Linguistics at CMU. This processing involves lexicon acquisition and automatic parsing into phrasal units that are clustered into equivalence classes and candidate terminological links. Human domain experts are given this information in the context of an information structuring system to formally encode a thesaurus of software risks. This preliminary structure is "edited" by the Risk Program staff to arrive at an acceptable taxonomy of software risk.

In conjunction with the field tests, a package is being developed to train assessment team members in the method of applying the taxonomy-based questionnaire and to analyze the field test data.

The taxonomy-based questionnaire, the analytical methods, and the training material are to be transitioned to both the Government Risk Management and the Industry Risk Management Projects for use in developing risk assessment processes.

Project members developed the project plan that will result in the delivery of the taxonomy-based questionnaire in the second quarter of 1993. Specifically, project members:

- Parsed data from field tests (risk assessments) #1, #2, and #3. This parsed data was analyzed by the CLARIT software with the results feeding into the development of new questions for the existing taxonomy-based questionnaire. This resulted in Version 1.1 of the taxonomy-based questionnaire.
- Developed a presentation on the taxonomy-based questionnaire for the SEI Software Engineering Symposium, held in Pittsburgh in September. Presented the current taxonomy at the symposium and collected data with a taxonomy-structured questionnaire.
- Conducted taxonomy field test #1 in July using version 1.1 of the taxonomy-based questionnaire.
- Restructured the taxonomy based upon data analysis of field test data and other associated literature. The analysis was done by both the CLARIT software and project members. This resulted in version 1.2 of the taxonomy-based questionnaire.
- Integrated first-level analysis into the taxonomy field test activities.
- Developed a training package, version 1.0, to train team members on how to apply the taxonomy-based questionnaire and analyze the resulting risk data.
- Conducted taxonomy field test #2 in September using taxonomy Version 1.2 and training material Version 1.0.

Project members are continuing to develop the taxonomy-based questionnaire, training material, and analytical methods.

SEI Services

SEI Services works with other groups in the SEI to develop, deliver, and transition services that support the efforts of SEI clients to improve their ability to define, develop, maintain, and operate software-intensive systems. To accelerate the widespread adoption of effective software practices, SEI Services works with client organizations that are influential leaders in the software community, promotes the development of infrastructures that support the adoption of improved practices, and transitions capabilities to government and commercial associates for use with their client organizations.

The Computer Emergency Response Team (CERT) was formed by DARPA in November 1988 in response to the needs exhibited during the Internet worm incident. The CERT charter is to work with the Internet community to facilitate its response to computer security events involving Internet hosts, to take proactive steps to raise the community's awareness of computer security issues, and to conduct research targeted at improving the security of existing systems.

To facilitate the community's participation in developing methods, tools, and techniques to prevent or deal with computer security incidents, the CERT staff organized two major conferences this quarter.

The Fourth Workshop on Computer Security Incident Handling was held in Denver on 4-6 August. The workshop consisted of tutorials, paper presentations, and panel discussions. The workshop was attended by 150 practitioners, 110 of whom attended the tutorials offered.

The Third USENIX Unix Security Symposium was held in Baltimore on 14-16 September. The symposium consisted of tutorial sessions, refereed papers, and panel discussions. This symposium was not held last year, and there was concern that the attendance would not reach the goal of 250. Actual attendance of 270 exceeded expectations.

To raise the community's awareness of computer security issues, CERT staff were invited speakers at the following events:

- National Science Foundation meeting to plan a Network Security Policy Invitational Workshop to be held early in 1993.
- Meeting with administrators at JANET in London, England, to discuss security issues within their network domain.

Considerable time has been spent this quarter preparing to host the First CERT Workshop on Research in Incident Handling. This invitational workshop will be 5-6 November, and will be attended by the major researchers in systems security and incident handling.

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**Computer Emergency
Response Team**

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**Software Process
Assessment**

The Software Process Assessment (SPA) Project helps organizations improve their software development process by providing a structured method for assessing their current practice, as well as continuously improving the assessment method and ensuring its focus on organizational process improvement. The objectives of the assessment method are to identify key areas for improvement, utilizing the SEI process maturity model as a framework, and to help the organization initiate those improvements.

During this quarter, SPA project members were involved primarily in the development of products upon which the SPA method is highly dependent. Project staff contributed heavily to the development of a CMM application rating method that will be used to ensure a consistent method for determining process area satisfaction in SPAs and SCEs. In addition, project staff participated heavily in reviewing and revising CMM V1.0, based on change requests received from the software community. In preparation for its own SPA method development work to accommodate use of the CMM, its rating method, and new maturity questionnaire, the project staff worked on documenting the rationale for the current method structure. This information will form the base on which the new method will be documented for public use.

In addition to its development efforts, SPA staff continued to consult with those industry and government software organizations that are involved in process improvement activities as well as assessments. SPA project staff also delivered training to SPA associates, including eight vendors and four staff members from the Air Force Technology Integration Center.

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**Improvement
Planning and
Organizing**

The Improvement Planning and Organizing (IPO) function focuses activities with SEI clients who seek long-term support for their software process improvement efforts. IPO was formed to address needs for integrated software process improvement programs that include: understanding the principles of how to effectively launch and sustain continuous software process improvement; and integrating assessments, organizational dynamics, the maturity model, process definitions, and improvement metrics into a plan. IPO members provide support in planning and organizing continuous software process improvement programs including: using business/case histories in software process improvement to illustrate benefits achieved; promoting and launching software process improvement programs; and coordinating clients' activities with the work of different SEI projects.

Staff members continue to support two current major clients (Air Force Logistics Command and the Army Material Command) in continuing their assessments and improvement efforts. Between these two commands, IPO staff members are supporting 13 different improvement programs.

Staff members began planning support for the SSC at Gunter AFB.

Staff members are working with the Center for Information Management (CIM) in several areas, including software process improvement planning and technology transition.

Staff members began planning the 1993 Fifth National Software Engineering Process Group (SEPG) Conference in conjunction with the Software Process Improvement Network, located in Irvine, California.

Staff members presented a tutorial on planning a process improvement program at the 1992 SEI Software Engineering Symposium. More than 200 people attended this tutorial. IPO project members also coordinated or presented at several symposium sessions on lessons learned from software process improvement programs.

Staff members delivered an action planning workshop on strategic planning to several clients and have updated the materials from the pilot version. The new version will be delivered in 1993.

This quarter, the group entered into agreements with the Technology Integration Center (TIC) of the U.S. Air Force to provide action planning workshops and mentoring to the initial two improvement clients of the TIC.

The Organization Capability Development (OCD) function supports SEI clients' software process improvement efforts by helping the client organizations develop the capability to manage the organizational aspects of improvement at their sites. Services include organizational assessment, vision setting and dissemination, strategic planning, transition infrastructure development, executive consulting, cross-functional team development, managing technological change, and consulting skills for software engineering process groups. The goal of the function is to provide to clients the self-sustaining capability of managing their own long-term improvement.

The Consulting Skills Workshop was offered three times: once for the Air Force under the sponsorship of the Embedded Computer Resources Support Improvement Program (ESIP), once for Oklahoma City Air Logistics Center, and a third time to the public.

OCD staff members consulted with Aerospace Guidance and Metrology Center in Air Force Materiel Command (AFMC) in preparation for their software process assessment.

Staff members participated in a presentation on improvement programs at the SEI Software Engineering Symposium.

This quarter, project members participated in an AFMC software engineering process group conference organized by the Sacramento Air Logistics Center SEPG.

The Managing Technological Change course was offered to the Air Force under the sponsorship of ESIP.

Staff members provided ongoing improvement consulting to members of AMC, AFMC, and SSC.

An Analysis of SEI Software Assessment Results
(CMU/SEI-92-TR-24)

For information about ordering copies of SEI reports, see page 37.

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**Organization
Capability
Development**

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**SEI Services
Reports**

July—September 1992

SEI Products

With the goal of helping end-users help themselves, SEI Products works with other groups in the SEI to develop an integrated set of products and services for managers, practitioners, and educators. SEI Products ensures that the results of SEI work are in a form that the software community can easily and effectively use to improve software practice and that educators can use to improve software engineering.

The Academic Education Project focuses on the long-term development of a highly qualified work force. The project promotes and accelerates the development of software engineering as an academic discipline. The project is developing model curricula and promoting the establishment and growth of software engineering programs, as well as working to increase the amount of software engineering content in computer science programs. The project produces educational materials that support the teaching of software engineering in universities.

During this quarter, the project hosted three visiting scientists: Laurie Werth and John Werth, from the University of Texas, Austin, and Henry Etlinger, from the Rochester Institute of Technology. These professors contributed to the development of a model curriculum for an undergraduate software engineering degree program and the design of educational materials to be released in 1993.

At the 1992 SEI Software Engineering Symposium, the project conducted a joint session with the MSE Project. The project leader presented current and planned work toward the definition and establishment of undergraduate degree programs. The session included a discussion of transition issues and ways to address them.

The Continuing Education Project interacts with industry and government to increase the availability of high-quality educational opportunities for software practitioners and executives. The project produces the Continuing Education Series and the Technology Series. The Continuing Education Series provides video-based courses designed for clients' in-house education, and executive offerings designed for decision makers involved in improvement efforts. The Technology Series provides stand-alone presentations that promote awareness of emerging issues and leading-edge technologies.

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Academic Education

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Continuing Education

The Continuing Education Series executive seminar, Software Quality Improvement, was taught for the AMC at Ft. Sill, Okla., on 21-23 July. There were 29 participants.

A major revision of the Continuing Education Series executive seminar "Software: Profit Through Process Improvement" was completed and delivered to clients on 28-29 September. The 10 participants represented Electronic Systems Command, Grumman Corporation, Pacific Bell, Scott AFB, the State of Minnesota (Department of Labor), Thomson CSF (France), the US Navy, and the US Treasury Department (Bureau of Alcohol, Tobacco & Firearms).

Preparations were completed for the Sixth SEI Conference on Software Engineering Education, to be held in San Diego in early October. The proceedings were published by Springer-Verlag and copies received for distribution at the conference. As of 30 September, more than 200 educators, trainers, and managers were registered.

At the 1992 SEI Software Engineering Symposium, the Continuing Education Project presented three sessions to highlight SEI educational products: "Using SEI Practitioner Courses for In-House Training," "Executive Curriculum: Process Improvement Through Management Leadership," and "Educational Products for Software Practitioners." The project also produced and distributed a survey to elicit feedback from SEI clients on their needs for CMM-based education and training.

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**Master of Software
Engineering**

In response to industry's growing demand for skilled software developers, CMU offers a 16-month master's degree program in software engineering. The program is a cooperative effort of the CMU School of Computer Science and the SEI. The core of the program is based on the SEI curriculum recommendations for MSE programs. The MSE Project also produces the Academic Series, a set of video-based graduate-level courses on software engineering.

The Carnegie Mellon MSE program welcomed nine new students for fall, 1992.

At a joint symposium session with the Academic Education Project, the project leader discussed modularized educational products for both undergraduate and graduate software engineering education.

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**Software Capability
Evaluation**

The Software Capability Evaluation (SCE) Project helps DoD acquisition organizations evaluate the capability of contractors to develop and maintain software competently. The project is improving and implementing an evaluation method that examines the software process of contractors for use in software-intensive acquisitions.

SCE team training was conducted in July and August. In early August, team training was conducted at the MITRE Institute in Bedford, Massachusetts in support of the United States Air Force (USAF) Electronic Systems Center. This was the project's second delivery of the team training at a strategic customer site. A total of 16 teams (93 individuals) were trained during this quarter.

The SCE Overview Seminar was conducted in early August to a full capacity audience of 30 participants. This one-day offering is available to both government and industry and its discussions focus on what SCE is and how the government is currently using the SCE method.

This quarter, three deliverables were provided to the Computer Resource Technology Transition office under a TO&P:

- Electronic Systems Division SCE Installation Plan (Draft).
- Two SCE Overview briefings.
- V1.0 SCE Implementation Guide.

The V1.0 Implementation Guide has been distributed to approximately 30 individuals on an industry review group. Comments have been received, and they are being incorporated into the guide.

The SCE project conducted the first SCE Users Workshop in Pittsburgh during July. Approximately 100 attendees from the SEI, government, and industry participated. Workshop results were mailed to participants in August.

During this quarter, five SCE site visits by the government were observed by project members, two of which were done in support of pilot use of SCE with the project's strategic partners. In addition, for the first time, multiple site visits of the same SCE team during a single acquisition were observed.

The SCE project supported an Air Force Materiel Command working group that is chartered to investigate how current evaluation methods used by the USAF (including SCE) might be merged into one technique. Various product materials were sent to the group in August, and Woody Mead presented an SCE Overview to the working group during September.

SCE project members supported efforts of the Institute for Defense Analysis (IDA) on the DARPA sponsored task reported during the last two quarters. Results of this task force were presented to the SEI by IDA representatives during August.

A project member presented a tutorial on SCE at the 1992 SEI Symposium. SCE information and status was also presented during the session on CMM-based products at the symposium.

Program Development

The vision of the Program Development Division (PDD) is to serve customer needs by being the voice of the customer to the SEI and the voice of the SEI to the customer.

PDD accelerates the transition of new SEI software technologies and methods by disseminating information, providing mechanisms for collaboration and technology exchange, and offering customers the opportunity to participate in technical interchange meetings, workshops, and educational offerings. Efforts used to facilitate this transition include the Customer Relations information line, the subscriber program, the resident affiliate program, events such as the annual SEI Software Engineering Symposium and Visitors Days, and distribution partners.

The subscription program, in effect since January 1992, is open to any individual with a U.S. mailing address. Subscribers receive regular publications such as Bridge, invitations to selected SEI events (e.g., the annual SEI Symposium), and first notification of SEI course offerings and new technical reports. The fee for subscription is \$100 per individual per calendar year. The program applies only to industry and academia; government individuals receive the same benefits at no cost through controlled distribution. For more information, see page 37.

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The SEI Software Engineering Symposium was held in Pittsburgh on 15-17 September. An optional day of tutorials was offered on 14 September. The symposium brought together software practitioners, managers, and educators to examine the state of software engineering technology and practice in light of SEI projects and plans. SEI products and services, as well as technical focus areas, were highlighted this year. In addition to the symposium proceedings, attendees received the first copies of the newly released SEI Products and Services Portfolio as well as several new technical reports on software measurement and an updated report on the state of the software engineering practice.

Visitors Day is a quarterly event hosted by the SEI to familiarize software practitioners, managers, and educators with the SEI. The next two Visitors Days are scheduled for 4 December 1992 and 18 February 1993. Visitors must pre-register with Customer Relations; walk-ins will not be accommodated. For more information about Customer Relations, see page 37.

This quarter, one new resident affiliate joined the SEI from the Department of Defense, one from Paramax, and one from Computer Sciences Corporation.

The following organizations sponsored resident affiliates in the third quarter of 1992.

Industry	AT&T Bell Labs
	Boeing
	Computer Sciences Corporation
	GTE Government Systems
	Hughes Aircraft Company
	IBM
	Lockheed Missiles and Space Company, Inc.
	Pacific Bell
	Paramax
	Texas Instruments
Government	
Air Force	Electronic Systems Division
	Coastal Systems Station
Navy	Naval Ocean Systems Command
	Communications-Electronics Command
Army	Defense Logistics Agency
	National Security Agency
Other DoD	
Academia	
	Polytechnic University of Madrid (Spain)

For More Information

For information about purchasing SEI publications, contact one of the following organizations:

RAI	Research Access Inc. 3400 Forbes Avenue, Suite 302 Pittsburgh, PA 15213 Telephone: 1-800-685-6510 FAX: (412) 682-6530
NTIS	National Technical Information Service U.S. Department of Commerce Springfield, VA 22161-2103 Telephone: (703) 487-4600
DTIC	Defense Technical Information Center ATTN: FDRA Cameron Station Alexandria, VA 22304-6145 Telephone: (703) 274-7633

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**How to Order SEI
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For information on the subscriber program and other SEI offerings, contact:

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Pittsburgh, PA 15213-3890
(412) 268-5800
Internet: customer-relations@sei.cmu.edu

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**How to Get Additional
Information**

List of Acronyms

ACEC	Ada Compiler Evaluation Capability 10
ACM	Association for Computing 10
AES	Ada Evaluation System 10
AFB	Air Force Base 1
AFMC	Air Force Materiel Command 29
AMC	Army Materiel Command 2
AMCCOM	Armament Munitions and Chemical Command 3
ARTEWG	Ada Runtime Environment Working Group 10
AT&T	American Telephone and Telegraph 3
ATCCS	Army Tactical Command and Control System 16
CASE	computer-aided software engineering 17
CCI	Competence Center Informatik 21
CECOM	Communications-Electronic Command 16
CERT	Computer Emergency Response Team 27
CIM	Corporate Information Management 1
CM	configuration management 17
CMM	capability maturity model 2
CMU	Carnegie Mellon University 7
CSS	Coastal Systems Station 16
DARPA	Defense Advanced Research Projects Agency 3
DISA	Defense Information Systems Agency 1
DISC4	Information Systems for Command, Control, Communications, and Computers 16
DoD	Department of Defense 1
ESIP	Embedded Computer Resources Support Improvement Program 29
GE	General Electric 16
HOS	Highway Operations System 18
IDA	Institute for Defense Analysis 33
IEEE	Institute of Electrical and Electronic Engineers, Inc 11
IFIP	International Federation of Information Processing 12
IPO	Improvement Planning and Organizing 28
IRM	Industrial Risk Management 24
IV&V	Independent Verification and Validation 9
LCSEC	Life Cycle Software Engineering Center 3

MICOM	Missile Command 3
MSE	Master of Software Engineering 7
MTV	Message Translation and Validation 15
NASA	National Aeronautics and Space Administration 9
NAWC	Naval Air Warfare Center 1
NGCR	Navy Next Generation Computer Resources 7
NRC	Nuclear Regulatory Commission 16
OCD	Organization Capability Development 29
PAL	Process Asset Library 3
PDR	preliminary design review 16
PEO	program executive officer 16
PH	periodic harmonic 10
PIWG	Performance Issues Working Group 10
PN	periodic nonharmonic 10
POSIX	Portable Operating System Interface Standard 7
REST	Real-Time Embedded Systems Testbed 9
RFP	request for proposals 8
RMA	rate monotonic analysis 7
RMARTS	Rate Monotonic Analysis for Real-Time Systems 8
SAME	SQL Ada Module Extension 21
SAMeDL	SQL Ada Module Description Language 21
SCM	software configuration management 17
SDWG	Software Dependability Working Group 11
SEPG	Software Engineering Process Group 3
SIGAda	Special Interest Group for Ada 10
SPC	Software Productivity Consortium 9
SPD	Software Process Definition 2
SQL	Structured Query Language 21
SSC	Standard Systems Center 1
STARS	Software Technology for Adaptable, Reliable Systems 2
TC	technical committee 12
TIC	Technology Integration Center 29
TO&P	technical objectives and plans 1
USAF	United States Air Force 32
WAdaS	Washington Ada Symposium 8
X3H2	Database Committee 21